CTIA
The Wireless Association™

Expanding the Wireless Frontier

September 25, 2014

VIA ELECTRONIC FILING

Marlene H. Dortch
Secretary, Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: ***Protecting and Promoting the Open Internet,*** **GN Docket No. 14-28;**
Framework for Broadband Internet Service, **GN Docket No. 10-127;**
Seventh Annual Report on the State of Competition in Mobile Wireless,
WT Docket No. 13-135

Dear Ms. Dortch:

To provide a better understanding of the critical role that spectrum plays in providing the mobile broadband services expected by consumers, CTIA – The Wireless Association® ("CTIA") submits the attached study by Recon Analytics that examines the U.S. wireless marketplace and analyzes the effect that spectrum has on the provision of services to subscribers. Recon Analytics finds that, in studying G7 mobile broadband deployments, the U.S. has:

- the highest customer satisfaction of any country,
- the most 4G LTE subscribers,
- the most capital invested in mobile broadband networks, and
- the least amount of dedicated 4G LTE spectrum.

Additionally, the paper describes the hurdles wireless providers in the U.S. face in pursuing and maintaining leading speeds. As the paper notes, the U.S. is a victim of its own success due to the shortage of dedicated LTE spectrum and because U.S. wireless providers have not employed premium pricing for 4G LTE services. The second of these factors has contributed to rapid 4G adoption and prompted U.S. customers to more heavily use mobile broadband services than is the case in some other G7 countries, who by contrast, have recently enjoyed faster speeds because they have fewer 4G subscribers, using more spectrum to deliver their traffic to less subscribers. Recon Analytics finds that the Commission must accelerate the identification and allocation of additional mobile broadband spectrum, preferably in wide-channel bandwidths, to allow the U.S. mobile broadband system to continue to innovate, invest and deliver upon its G7-leading customer experience.

The Commission has embarked upon two separate efforts to study and potentially adopt additional regulation of the mobile broadband ecosystem. CTIA believes that this paper will help inform the record in the dual efforts of the Commission in the Open Internet and Mobile Competition areas, and is filing this paper in both active proceedings.

The paper, Spectrum Fuels Speed and Prosperity, is authored by Roger Entner, the Founder and Analyst at Recon Analytics. Mr. Entner is one of the leading experts researching the wireless experience, how it influences customer behavior and how customers make choices.

In his paper, Mr. Entner finds that a lack of new mobile broadband spectrum has constrained the U.S. wireless industry's ability to deliver data speeds comparable to some of its G7 peers and increased the cost of delivering high speed service. In spite of the lack of dedicated 4G LTE spectrum, Mr. Entner shows that U.S. wireless providers have the most satisfied customers of any country in the G7 because they have spent more in total capital expenditures and the second-most per inhabitant. These extensive capital investments have allowed U.S. mobile providers to drive efficiencies into their networks and allowed them to maintain a high subscriber satisfaction even though the U.S. has the least concentrated population among the G7 countries. Mr. Entner finds that smartphone adoption, 4G LTE network rollouts, customer adoption of 4G LTE and use of mobile broadband services (such as video conferencing and video streaming) are highest in the United States as compared to the G7 countries. He traces this growth to the lack of premium pricing placed on 4G LTE services by U.S. wireless providers as well as the extensive network investments that allowed for broadband data rates that allowed for the delivery of acceptable smartphone services.

CTIA believes that these findings are directly applicable to the ongoing proceedings concerning the Open Internet and Mobile Broadband Competition. Initially, Recon Analytics describes in detail why allowing mobile broadband providers the freedom to manage their networks has provided extensive consumer benefits. In particular, because U.S. mobile broadband providers have not been limited in how they may manage and evolve their networks, they have been able to manage them on a real-time, dynamic basis. This in turn has allowed wireless providers the ability to provide mobile data rates that are sufficient to cause G7-leading adoption of smartphones, broadband data services (such as video streaming) and use of 4G LTE throughout the country. Indeed, the paper determines that the fundamental premise asserted by CTIA – spectrum scarcity – is the issue that the Commission must focus its resources on. And the substantial operational challenges resulting from spectrum scarcity should be reflected in the FCC's Open Internet rules.

In addition, the paper supports the idea that mobile broadband competition in the U.S. is robust and continues to lead all G7 countries. U.S. consumers have the highest satisfaction of any G7 country, which is driven by the extensive competition among wireless providers. They also are the most likely to have a smartphone, to use mobile broadband services and are not charged premium pricing for 4G LTE access. All these metrics demonstrate that competition in the U.S. is flourishing and inuring to the benefit of consumers. Moreover, because the U.S. wireless ecosystem consists of four national wireless providers along with countless number of smaller regional and local providers, licensed mobile broadband spectrum rights have been divided extensively throughout the country. While this division of spectrum rights has been beneficial to competition, it leads directly to the need for extensive amounts of additional spectrum to be dedicated for 4G LTE services so that these myriad providers have sufficient resources to provide the mobile broadband data rates expected by consumers. The Commission must redouble its efforts to finding more mobile broadband spectrum so that all the providers in the wireless marketplace have access to sufficient spectrum resources. The best thing the FCC

can do to ensure a more robust and vibrant mobile broadband experience is to provide more spectrum, to meet the demands for faster and faster data rates by subscribers.

CTIA hopes that the Commission will give full consideration to the analyses found in the Recon Analytics paper when reaching a final determination on how to move forward with its Open Internet and Mobile Competition proceedings. CTIA strongly believes that the current mobile-specific, light-touch regulatory model promulgated by the Commission has allowed the U.S. wireless ecosystem to provide the highest penetration of 4G LTE services, best customer satisfaction and greatest adoption of smartphones of any country in the G7. The Commission should not take any action that would endanger this enviable position but should instead focus on the identification and allocation of additional mobile broadband spectrum to further enable the mobile broadband industry to deliver the innovation and investment expected by U.S. consumers.

Pursuant to Section 1.1206 of the Commission's rules, a copy of this letter is being filed in the above captioned dockets in ECFS. Please do not hesitate to contact the undersigned with any questions.

Sincerely,

/s/ *Scott K. Bergmann*

Scott K. Bergmann
Vice President – Regulatory Affairs
CTIA-The Wireless Association®

SPECTRUM FUELS SPEED AND PROSPERITY

By Roger Entner, Founder and Analyst
Recon Analytics

Executive summary

The wireless industry is a key contributor to the US economy—creating jobs and GDP as well as countless economic and social benefits. This remains a fact despite reports earlier this year that US mobile speeds have lagged some of its trading partners. In this report, we explore the realities behind these reports, and what can be done to address them. Among the many factors that contribute to download speed across countries are the availability of 4G spectrum, capital expenditures, the way people use their phones, the phenomenon of urban agglomerations, and pricing.

In this executive summary, we highlight a number of facts:

- The US was the early leader in 4G speed, but world-leading mobile broadband adoption combined with the lack of new spectrum has constrained the industry's ability to deliver faster speeds, and has increased the cost of delivering such high-speed service.
- There is a positive correlation between channel sizes and observed download speeds. Countries that deploy larger channel blocks generally have faster download speeds, and enjoy greater trunking efficiencies in higher-density markets that produce additional economic benefits.
- The US spends more in capital expenditures than any G7 country and the second-most per inhabitant.
- More than any other G7 country, Americans use their phones for tasks that rely on the speed of a 4G LTE network, such as watching movies and TV and using video applications (e.g., making video calls).
- Contrary to conventional wisdom, the US has the least concentrated population among the G7 countries. We developed the Urban Agglomeration Index (UAI) to quantify population concentration. We found that every other G7 country has much higher UAIs than the US, which means that operators in those countries can focus investment on significantly fewer places to make a large impact on average network performance.
- Unlike other G7 countries, US operators do not charge a premium for 4G access. As a result, US networks are more highly trafficked than in countries where download speeds are tied to premium pricing. Furthermore, in countries with premium pricing average speeds are higher, but median speeds are lower than in countries where there is no premium pricing for LTE (like in the US). In other words, despite the average speed difference, more US subscribers experience high download speeds than people in other countries.
- Among the G7 countries, US customers are the most satisfied with their wireless operator and their smartphones.

The impact the mobile industry has on the US economy was inconceivable even 20 years ago. The social and economic benefits for the country are dramatic, profound and transformative. To continue these powerful contributions, the United States must accelerate spectrum availability for operators and consumers. The upcoming AWS3 and incentive auctions will only partially alleviate spectrum needs. Additional licenses need to be made available quickly so that the US shores up the fundamentals it needs to maintain leadership in innovation and customer satisfaction as well as increase the prosperity of the country.

Through their large capital expenditures, operators provide the fuel to accelerate the economic benefits of the wireless industry for the US economy. The government has to do its share by adding more oxygen in the form of additional spectrum to rev up the wireless growth engine.

Table of contents

OVERVIEW

This report examines wireless download speeds, spectrum availability, capital expenditures, usage patterns, urban agglomerations, pricing, and satisfaction for carriers in the United States and fellow G7 member countries in assessing what needs to be done to ensure and maximize the continued economic contributions of the US wireless industry[1].

The first large-scale 4G LTE network in the world, Verizon's 4G LTE network, launched on December 5, 2010. AT&T followed ten short months later. These early network moves coupled with an abundance of affordable 4G LTE devices gave the US the fastest download speeds in the G7 until the second quarter 2012, as Americans adopted 4G LTE at a rapid pace. However, because of limited and shared spectrum resources, the popularity of 4G in the US has allowed others to jump ahead in speeds. For example, Canada overtook the US lead in speed in 2Q 2012, followed by Japan in 3Q 2013, and France in 1Q 2014.

The availability of spectrum is the oxygen that allows the wireless engine to run. The US has utilized the least amount of spectrum for LTE compared to its peers, driven both by significantly more subscribers and the third lowest amount of spectrum available in absolute terms and the lowest per-subscriber for LTE. Almost every country has made licenses of various channel sizes available for auction, but the US has far fewer wide-channel spectrum allocations than countries such as France. This is significant because these wide-channel allocations make it easier and more affordable to roll out advanced services like 4G.[2]

If spectrum is oxygen, then capex is the fuel that powers the wireless growth engine of the economy. Carriers in the United States, which has the most people and a vast coverage area, spent more on capex than carriers in any other G7 country. Japan, with the second most inhabitants, spends the second most. There is a significant chasm between the US and the rest of the G7. In 2013, US operators spent twice as much per person as British and German operators, while Japan spent three times as much per person as the British and German operators. Such capital expenditures in the US have made the download speeds we all take for granted possible. At the same time, carriers in France could spend less but get faster speeds because of the trunking efficiencies they gain with the wide, contiguous channels available to them, and the fewer 4G subscribers currently supported by their networks.

In most countries, the mobile phone has become the ubiquitous replacement for the camera. In all G7 countries, at least 76% of people have used their mobile to take pictures; in the United States, that figure reached as high as 84% in the first quarter of 2014.

For applications that need a fast network, a similar trend appears. Video calling, in particular, has made the biggest inroads in North America: 22% of Americans and 16% of Canadians make video calls, as of Q1 2014. British consumers are not far behind with 14%, while their continental counterparts are only half as likely to engage in video calling as Americans.

The US is a big country, but even though 82.4% of the population lives in cities, only about one-fifth of the total population lives in the top five largest urban agglomerations. In contrast, the population is considerably more concentrated in Japan, where the top five metro areas add up to nearly half of the Japanese population. Other countries in the G7 have similar advantages to

[1] We point to this author's 2012 report on the impact of the wireless industry on the US economy (http://reconanalytics.com/2012/04/essential-engine-of-us-economic-growth/) as well as GSMA's work. (http://www.gsma.com/publicpolicy/wp-content/uploads/2012/11/gsma-deloitte-impact-mobile-telephony-economic-growth.pdf).

[2] This is not to endorse exclusively wide-channel allocations. Rather, it is to note the real world impacts of a lack of a sufficient number of such allocations. Policy reasons favor a mix of channel allocation sizes, but it must be understood that the lack of sufficient wide-channel allocations has ongoing impacts for carriers, consumers and the economy. Technologies like spectrum aggregation have the ability to partially alleviate these issues.

Japan—their population is concentrated and a lot of people live in a few places. The US is different; it has many agglomerations, but it is geographically dispersed. We created the Urban Agglomeration Index to understand these differences and the challenge it presents to a carrier looking to build out a network and cover the most people for the lowest cost.

In the UK and the rest of Europe, wireless licenses have typically been technology-specific, while in the US, license owners can use any technology they choose. This has the effect of limiting the potential number of partners for a carrier.

As far as pricing is concerned, US carriers have followed a strategy of pricing 4G at par with 3G. This encourages adoption and ensures that many customers make the switch to the new network with a new device. Apart from Canada (which has a similar approach to the US), for the most part, other G7 countries charge a premium for 4G access. This has dual effects: It limits the number of people who'll switch from slower 3G (and even 2G) networks and ensures that the 4G networks won't be bogged down with traffic, which has the effect of speeding up the service, because the networks experience less demand for the shared 4G spectrum.

Making customers happy takes more than a combination of devices and network speed. With a higher penetration of 4G and smartphones than any of its G7 counterparts, no consumers among the G7 countries are more satisfied with their smartphones and carriers than those in the US.

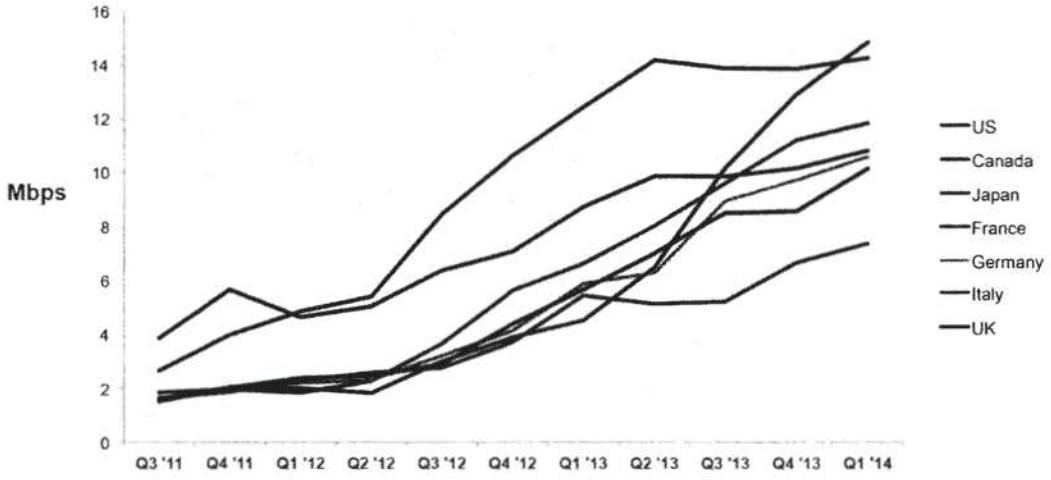
In this report, we examine the differences we just outlined, but, more importantly, we investigate the underlying causes of those differences, and both their implications for future economic and social benefits, and measures that can be taken to improve those benefits. The most important of these measures is for the government to accelerate the availability of more spectrum for commercial mobile service.

1. DOWNLOAD SPEEDS

Verizon Launches First Large-Scale 4G LTE Network

On December 5, 2010, Verizon launched the first large-scale 4G LTE network in the world, followed by AT&T merely ten months later. The aggressive early deployment of 4G LTE and the availability of a significant number of affordable 4G LTE devices provided American consumers with the fastest download speeds in the world until the first quarter 2012. At that point, we observe significant speed increases with the subsequent introduction of large-scale LTE networks in the other G7 countries (see Exhibit 1).

Exhibit 1: Average Mobile Data Speed by Country



Source: Ookla; Capture Date June 13, 2014

Canadian wireless users then took the speed crown from their neighbors to the south after Canadian carriers launched their 4G LTE networks in 2012. Canada only surrendered the lead to the French in the first quarter 2014 after French carriers launched their LTE network.

In subsequent chapters of this report we will discuss the reasons for the observed speed differences in the various countries.

Why this matters

Wireless download speeds are an important indicator of the kind of applications that can be used on a network as well as how productive and pleasurable it is to use your connected device. Waiting for a website to load or having a video turn into a slideshow due to low download speeds significantly reduces the utility of the device and frustrates users. Video has the most stringent benchmark: In order to run a standard resolution video without interruptions, a device needs at least 1 Mbps download speeds, HD video needs 5 Mbps, and Ultra-HD video needs 10 Mbps. But accepting download speeds at face value can be deceiving. Wireless download speeds are a product of the use of a shared resource. The more people that download at a certain location the slower the speed gets. It says nothing about how large a network is, or the benefits that are delivered by such a broadly available and used network. For example, a 4G network that's

available only to a fraction of the population in a limited area is not nearly as valuable as a marginally slower network with a large and broad reach. That limited 4G network might be fast, but its actual utility can be very limited. Nonetheless, the figures do help paint an important picture of a phase in wireless rollout. Speeds in France have recently risen on the back of channel allocation that was more heavily skewed to large channel sizes (to drive inherent network efficiencies of large channels) even though they auctioned some blocks as small as 5 MHz x 5 MHz (which accommodate smaller carriers). The US, which has seen speeds continue to increase, albeit at a slower pace, has done so with less utilized 4G spectrum than many other countries even though it has many more subscribers, both in total numbers and as a percentage of total subscribers.

2. SPECTRUM AVAILABILITY

Spectrum Is Like Oxygen

Just like pushing more oxygen into an engine to get more speed out of it, spectrum is the oxygen that translates into higher achievable speeds for LTE subscribers.

The US mobile broadband experience is the stuff of lore around the world, in part due to the smartphone revolution that first happened here, enabled by large, reliable wireless networks and innovative pricing strategies that made smartphones and Internet access a reality for hundreds of millions of Americans. The US was also the first to roll out fully commercial LTE networks that offered significantly higher speeds than ever before.

But, as we saw in Exhibit 1, the US recently fell behind in wireless download speeds compared to several other countries in the G7, largely as it became a victim of its own success. Wireless is a shared resource, so if spectrum is limited and demand for services is rapidly increasing, the share each customer can have goes down. On paper, the US seems to have a decent amount of spectrum, but it is generally already used for current services.

The FCC has scheduled the AWS3 auction, which is a welcome development but does not fundamentally change the fundamental lack of spectrum that we're facing in the US. Nor can the FCC's upcoming incentive auction be factored into this analysis of current spectrum allocations, just as other countries' on-going consideration of spectrum re-allocation and refarming is omitted.

Not everything that has been auctioned can or is used for LTE services. Legacy services such as GSM, CDMA, and HSPA—with hundreds of millions of customers across the G7 countries—need to be serviced. It's when we look at what is actually being used for LTE that the picture becomes a lot starker.

As we can see in Exhibit 2, the US has utilized the least amount of spectrum for LTE compared to its peers, a fact driven both by significantly more subscribers and the third lowest amount of spectrum available for LTE. In the simplest of terms (and all other things being equal), if there is less spectrum available per user, speeds will suffer. But, in fact, there were both more users and more heavy usage, along with less spectrum available per user, in the US than in the other G7 countries. Cisco's Mobile VNI Forecast shows that 4G connections generated more than three times the traffic of non-4G connections in 2013[3].

[3] http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/index.html#~Country

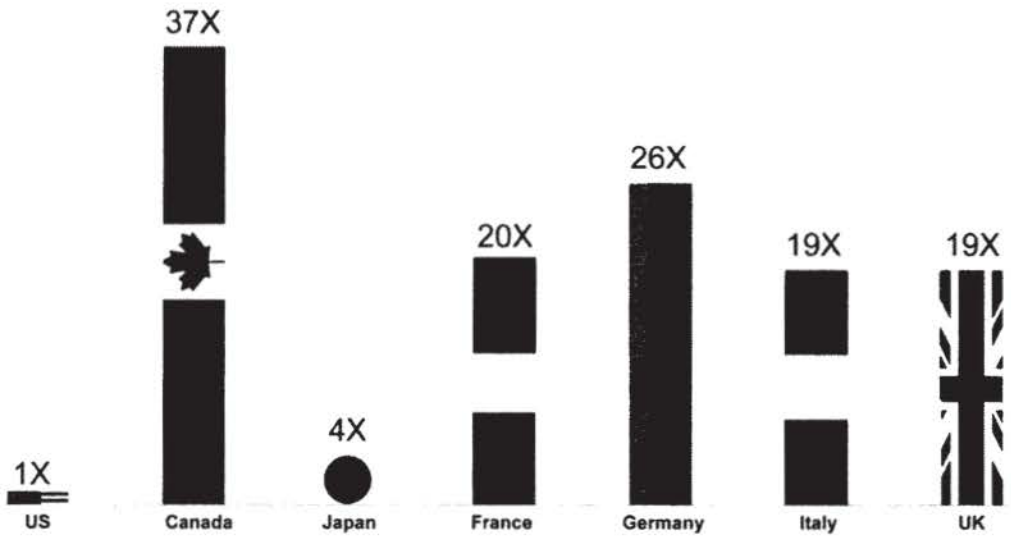
Exhibit 2: Deployed LTE Spectrum

	US	Canada	Japan	France	Germany	Italy	UK
FDD	57x57	72x72	100x100	80x80	60x60	15x15	55x55
TDD	20	30	30		20		
FDD Downlink and 2/3 of TDD	73	92	120	80	74	15	55
Subscribers in millions	330	27	122	73	107	89	76
LTE Subscriber	112.0	3.8	46.4	5.9	4.3	1.2	4.5
Hz/LTE subscriber	0.65	24.21	2.58	13.55	17.20	12.5	12.2

Source: Recon Analytics and Q1 2014 operator reports, 2014

Other countries have considerably more LTE spectrum available per LTE subscriber (see Exhibit 3). For example, Japanese carriers devote four times as much spectrum per subscriber to LTE as US carriers. In addition, Canadian carriers have a whopping 37 times the bandwidth while German operators have added 26 times what US operators have dedicated to serve their LTE customers. Considering that other countries have been able to bring so much more spectrum online for LTE customers, it is remarkable that the US is not much further behind when it comes to download speeds. That is a tribute to the ingenuity of the US wireless operators and the skilled engineers building and designing the wireless networks, and the significant investment made by US operators.

Exhibit 3: LTE Spectrum used per LTE subscriber



Source: Recon Analytics and Q1 2014 operator reports, 2014

This relative paucity of spectrum in the US has been aggravated by the way wireless licenses have been allocated—in terms of channel sizes. In the US, the largest channel size that was auctioned were three 15x15 MHz licenses in the PCS bands. Actually, over time, as the technical advantages of large channel sizes have become more apparent, the channel sizes auctioned have become smaller. Only as a benefit of mergers and acquisitions have US carriers been able to cobble together channels larger than 10x10 MHz and then only in a limited number of areas. Unlike the situation domestically, internationally, many countries have decided to align their spectrum policies with the advantages that physics and economics provides to larger channel sizes. This is not to disparage the policy reasons for a mix of allocation sizes, but to note the real-world impact of insufficient wide-channel allocations in the overall marketplace.

It's all about providing higher speeds at lower cost for the data-hungry masses of smartphone users, and limiting network congestion. The faster the network speed, the better the quality of video and data bits traversing the network. The lower the cost for consumers, the more they can actually enjoy wireless data services. Importantly, the impact that channel size has on network speed is very direct. Because wireless bandwidth is a shared resource, the speed with which packets traverse a mobile network is the fraction of the total bandwidth available divided by the number of concurrent users. Consider Exhibit 4, which illustrates the relationship between network speed and the size of the spectrum channel in a number of illustrative scenarios.

Exhibit 4: Network speed and channel size

LTE 4x2 MIMO	20 MHz Downlink	10 MHz Downlink	5 MHz Downlink	3 MHz Downlink	1.4 MHz Downlink
Aggregate capacity per sector	34 Mbps	17 Mbps	8.5 Mbps	5.1 Mbps	2.38 Mbps
Efficiency*	100%	98%	95%	90%	70%
Maximum peak speed with one user in a sector	34 Mbps	16.7 Mbps	8.1 Mbps	4.6 Mbps	1.7 Mbps
Expected average speed with five concurrent users in a sector	6.8 Mbps	3.3 Mbps	1.6 Mbps	0.9 Mbps	0.3 Mbps
Speed differential		49%	24%	14%	5%

Source: Recon Analytics, 2014; *Efficiency normalized to a 20 MHz channel

While the foregoing simple illustration suggests the relationship between network speed and the size of spectrum channels, it is in fact more complex. Not only is more money required to deliver the same volume of heavy traffic across different spectrum scenarios (making it cheaper to deliver bits under one scenario than another), but the resulting network cost-savings resulting from wide-channel trunking efficiencies allow the dedication of capital savings to produce other benefits to users. Wider spectrum channels make it easier to deliver faster speeds for accessing and downloading content because the wireless carriers have to manage just one contiguous channel. This is a result of what engineers call "trunking efficiency," which means that resources within a single larger channel can be more efficiently allocated than those from separate independent channels. In effect, channel sizes affect the design and cost of the network.

The faster the speed, the more satisfying the experience, which prompts more usage—and so the cycle goes. The most obvious advantage for consumers is that videos, which represent more than half of all bandwidth consumed on mobile networks, can be viewed without interruptions and at a higher quality than video delivered over narrow spectrum channels. As a result, small

businesses can more easily use video conference services, healthcare providers can more effectively use video for instruction or treatment, schools and libraries can more affordably use video-based instructional tools, and companies relying on mobile ad revenue for their next billion in revenue will be well served.

France's speed performance is a pretty clear-cut example of the significant impact that large channel sizes combined with relatively few customers can make on the speed of a network. It should come as no surprise that wider spectrum channels currently create faster speeds for the wireless broadband networks in this country. Operators around the world that have wider channels at their disposal are able to provide their customers faster wireless services at a lower cost (particularly in dense environments, because of scale economies and trunking efficiencies). Operators in countries with smaller channel sizes can make up some of the inherent disadvantages of smaller channel sizes by spending significantly more on capital expenditures. The relatively strong performance of the US is a testament of how far significant capital expenditure can get a country and where it reaches its limits. The economic and productivity improvements that result from the proliferation of more and faster wireless service have been shown conclusively in various studies[4] for both industrialized and developing countries. On the other side of that equation, countries where not enough spectrum is provided in a sizeable and timely fashion risk falling behind and not enjoying the full economic, social and technical benefits of on-going wireless innovation. Speed differences between countries at any one point in time may be ephemeral, but may also reflect fundamental factors that can help drive economic and social benefits and efficiencies, or undercut them by making it more difficult and expensive to deliver service.

Why this matters

As we noted, spectrum is like oxygen. In fact, it's very much like the air we breathe. We take it for granted. But this seemingly endless supply is, in fact, finite. And the way in which the US government allocates spectrum has been slow and limited. For the vibrant US wireless industry to continue to set the pace for the rest of the G7 and the world, there needs to be a reassessment of the measures the government employs. We need to consider the real world implications of such policies as allocating larger blocks, which translates into more efficient engineering and faster networks at lower capital expenditure levels.

[4] We point to this author's 2012 report on the impact of the wireless industry on the US economy, which includes considerable research on productivity gains (http://reconanalytics.com/2012/04/essential-engine-of-us-economic-growth/). Reports from GSMA (http://gsmamobileeconomyeurope.com/GSMA_Mobile%20Economy%20Europe_v9_WEB.pdf and http://www.atkearney.com/communications-media-technology/ideas-insights/the-mobile-economy-2013), University of Michigan (http://michiganmobilemusings.com/category/economic-impact-of-mobile-technology/), Ericcson (http://www.ericsson.com/res/thecompany/docs/sudan_economic_report.pdf), the Australian Communications and Media Authority (http://www.acma.gov.au/Industry/Spectrum/Spectrum-projects/Mobile-broadband/mobile-broadband-boosts-australias-economy), to mention only a few, show the positive effect of the wireless on economies around the world

3. CAPITAL EXPENDITURES

Capex: The Fuel That Accelerates Wireless Networks

If spectrum is the oxygen, then capital expenditures are the fuel that accelerates wireless networks. Unsurprisingly, carriers in the United States, which has the most people among the G7 countries and a large area to cover, spends more on capex than any other G7 member country. Japan, with the second most inhabitants, spends the second most. The smallest nation by population, Canada, spends the least. What is striking, though, is that in the midst of this technological transformation, all countries besides Canada have increased their spending on improving their wireless network year after year. Only Italy and Canada have not continuously increased their capex.

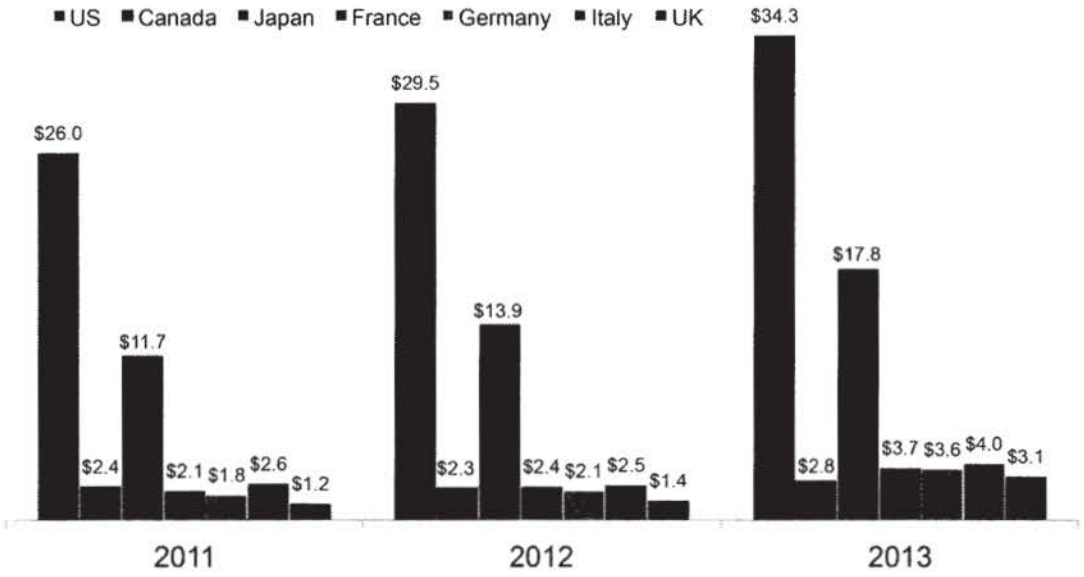
We can clearly see the effect on download speeds of stagnant or lowered capital investments. It takes about a year for the lowered fuel supply to be reflected in the speeds. For example, Canada, which was leading in wireless download speeds as of Q2 of 2013, stopped pumping network spending a year earlier and promptly download speeds plateaued. As a result, France, buoyed by its steady pace of investment increases, quickly overtook Canada as the country with the fastest wireless download speeds. Italy also plateaued in seventh place among the G7 countries after slowing the capex fuel supply in 2012 (see Exhibits 5 and 6). At the same time, this also works when more capital expenditure and/or more spectrum become available. A year later, you see an increase in download speeds.

Exhibit 5: G7 Capital Expenditures (in billions)

	US	Canada	Japan	France	Germany	Italy	UK
2011	$26.0	$2.4	$11.7	$2.1	$1.8	$2.6	$1.2
2012	$29.5	$2.3	$13.9	$2.4	$2.1	$2.5	$1.4
2013	$34.3	$2.8	$17.8	$3.7	$3.6	$4.0	$3.1

Source: Operator reports and Recon Analytics analysis, 2014

Exhibit 6: G7 Capital Expenditures (in billions)



Source: Operator reports and Recon Analytics analysis, 2014

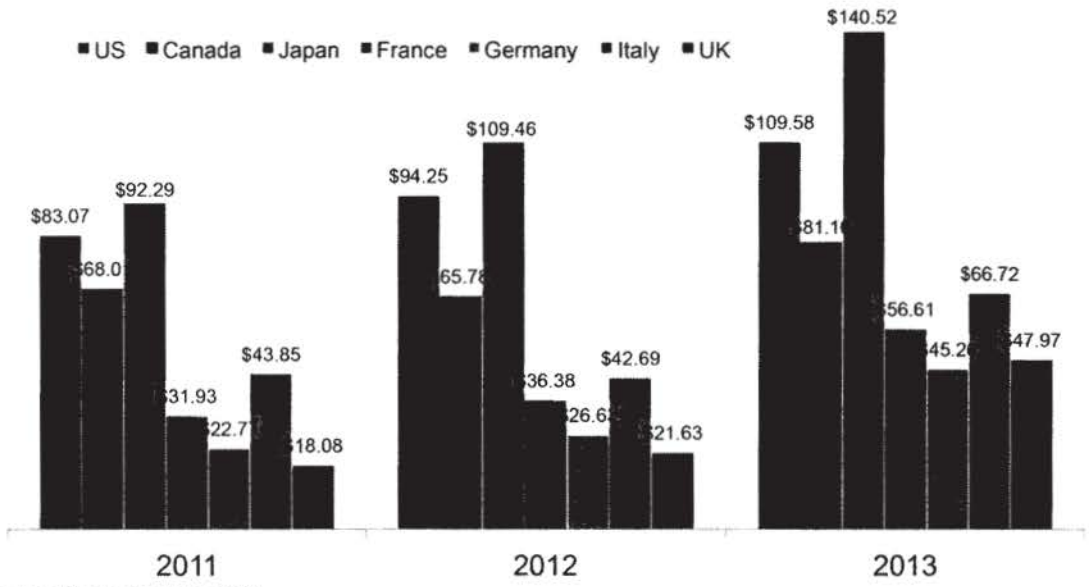
Another perspective on capital expenditures is per-capita capital expenditure (see Exhibits 7 and 8). With all of the G7 countries reaching subscriber saturation and growth coming from multiple device ownership and multiple carrier relationships, per-capita capital expenditure focuses on what really matters: How much is being spend to provide connectivity for each person. Here, the United States only trails Japan when it comes to capital expenditure per person.

Exhibit 7: G7 Per-Capita Capital Expenditures

	US	Canada	Japan	France	Germany	Italy	UK
Population in millions	313.00	35.10	126.70	65.60	80.50	59.70	63.70
2011	$83.07	$68.01	$92.29	$31.93	$22.77	$43.85	$18.08
2012	$94.25	$65.78	$109.46	$36.38	$26.63	$42.69	$21.63
2013	$109.58	$81.16	$140.52	$56.61	$45.26	$66.72	$47.97

Source: Recon Analytics, 2014

Exhibit 8: G7 Per-Capita Capital Expenditures



Source: Recon Analytics, 2014

There is a significant gap between the US and Japan and the rest of the world, and many of the remaining G7 countries. For example, in 2013, the US operators spent twice as much, and Japanese operators three times as much, on improving their networks than the British or German operators. Without the significant increase in capital investment in most of the countries, the download speed increases would not have been possible. Carriers in countries such as France, which have 20x20 MHz channels available for LTE, could achieve faster speed increases with lower investment because the efficiencies of wide, contiguous channels significantly boost the effect of the capital invested. In short, their money goes a lot further. The UK, with one exception, is using 5x5 MHz or 10x10 MHz configurations, so their speeds are slower.

In some countries (e.g., Canada and the UK), operators have sought to leverage their capital expenditures and reduce the number of network elements and sites they each need to build by sharing networks while still competing through customer-facing MVNO-like retail operations. In effect, operators coordinate their investment and network build-out. One result may be more efficient spectrum utilization, but with the trade-off of less competition based on network differentiation.

Why this matters

The key reason that the US wireless industry has not fallen further behind as it deals with limited bandwidth is the world-beating capex being poured into making the most of the limited spectrum available. It has supported growth in usage that is unrivalled in the G7. With additional spectrum, especially supported by larger channel allocations, the United States could have world-leading download speeds.

4. USAGE PATTERNS

About More Than Phone Calls

Of course, the mobile device is about more than phone calls now. It has become a powerful computer in the palm of your hand that can do things that only 20 years ago were solidly in the realm of science fiction. At the same time the devices have become more powerful so, too, have the networks. A 2G or 3G network lets device owners take pictures and share them with their friends and family. It also lets them listen to music streamed over the wireless connection. It requires a more powerful 3G network to watch a basic video with your phone. But if you want to do video calling, you better have a 4G network.

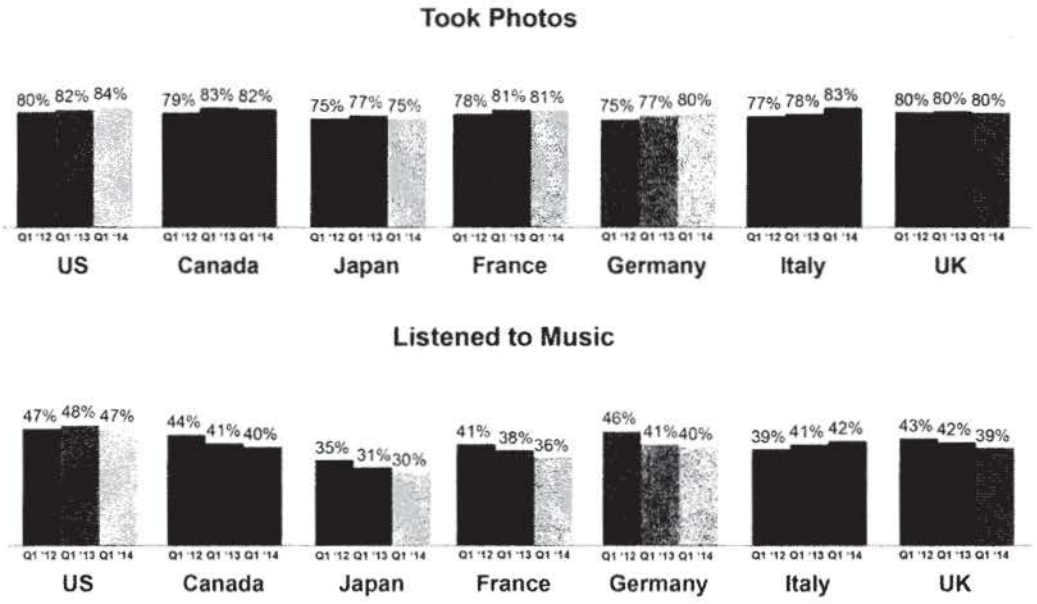
With that in mind, it's interesting to look at the activities of smartphone owners across the G7 to see the differences and similarities. These figures provide direct indication of how involved and integrated mobile devices are in the lives of the people in each given country.

Maybe surprisingly, Americans have integrated their mobile phone into their life more than consumers in any other G7 country (see Exhibit 9). Even more so, in the United States, the usage is increasing, both in terms of the many forms of mobile data and overall voice traffic volumes[5].

For example, in most countries, the mobile phone has become the ubiquitous replacement for the camera. In all G7 countries, at least 75% of people have used their mobile to take pictures. In the United States, that figure reached as high as 84% in the first quarter of 2014, the highest percentage of all G7 countries. This number shouldn't come as a surprise, considering the love affair that American youth (and adults) have with selfies.

[5] http://www.ctia.org/your-wireless-life/how-wireless-works/annual-wireless-industry-survey

Exhibit 9: Device usage possible on slow networks

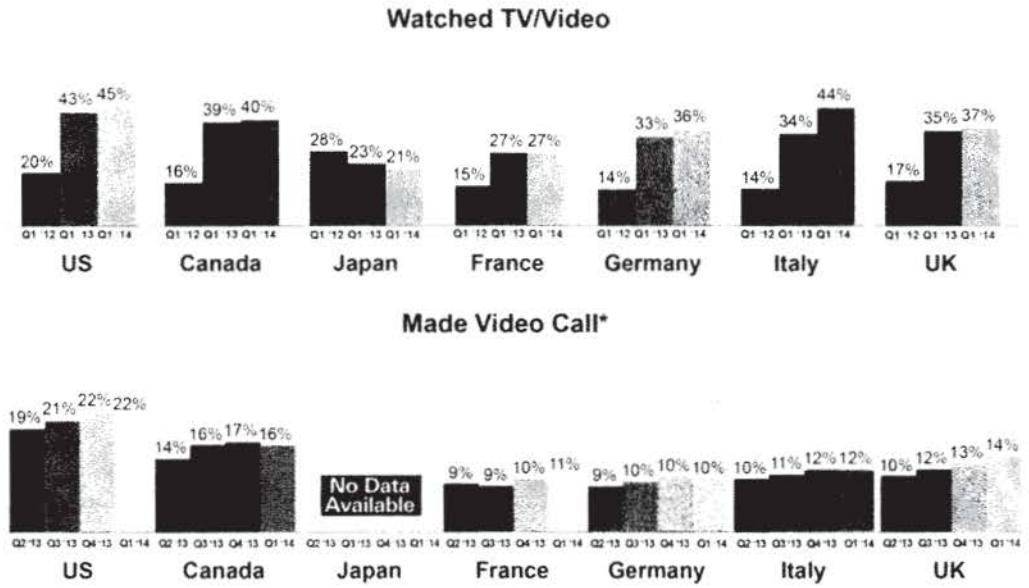


Source: comScore MobiLens. Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Video call question added to survey in Q2 2013

When we look at applications that need a fast network a similar trend appears. Americans use their mobile devices to watch videos and TV, as well as make video calls, more often than mobile users in any other country (see Exhibit 10). Here, despite technological progress and better wireless networks, Japan is falling behind. Usage figures illustrate a slide as the number of Japanese wireless users who watch a video or TV on a mobile device fell from a G7-leading 28% in 2012 to 21% in 2014, now dead last among the G7 countries. Again, this highlights how fast-changing the mobile sector is and how the reported metrics of countries can change rapidly in a short period of time.

Video calling, in particular, has made the biggest inroads in North America: 22% of Americans and 16% of Canadians make video calls, as of Q1 2014. British consumers are not far behind with 14%, while their continental counterparts are only half as likely to engage in video calling as Americans.

Exhibit 10: Device usage requiring fast networks



Source: comScore MobiLens. Quarterly data represented by 3-month average (with the exception of Canada – last month of quarter); *Video call question added to survey in Q2 2013

Why this matters

US consumers love their phones and they love rapid results. If the US had insufficient data speeds it would impede the effective use of advanced smartphones. As a result, the US would lag in the adoption of applications that require fast speeds. That is hardly the case. Despite not offering the world's fastest download speeds, the United States leads the world in adoption of smartphone services that take advantage of fast networks. Even though everyone would welcome faster speeds, the current speeds are not impeding adoption, especially when compared to the several other G7 countries that have, on average, faster networks. In fact, this situation also highlights an important distinction between "average" and "median." Although average speeds in some countries are higher than in the US, the median speed that consumers experience is probably higher in the US. This enables broader adoption of services that require fast download speeds.

5. AGGLOMERATION

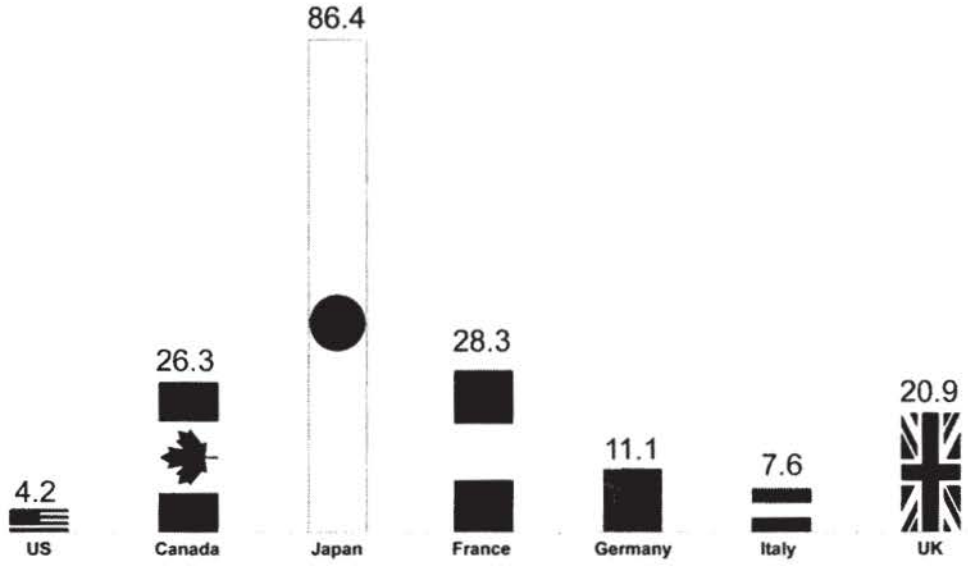
Background on The Urban Agglomeration Index

The Urban Agglomeration Index (UAI), created for this research, describes how concentrated the population of a country is. It takes into account the percent of the population of a country that lives in urban areas and what share of the urban population lives in the largest city. We have chosen to follow in the steps of the other prominent concentration measure, the Herfindahl-Hirschman Index, which is a cornerstone of describing market concentration.

Similar to the Herfindahl-Hirschman Index, in the UAI we square the percentage of people who live in urban areas and multiply it with the square of the percentage of the urban population that lives in the largest urban area. The Urban Agglomeration Index shows the impact that a highly urbanized country can have. In a country with a high UAI, the operators can focus on significantly fewer places and make a broad impact on network performance. This stands in contrast to countries with a low UAI, where people live in a more rural setting and in more numerous but comparatively smaller urban centers. In a high UAI country a carrier can concentrate capex in a relatively small area and enjoy a return on capex that is magnitudes greater.

Exhibit 11 outlines the Urban Agglomeration Index for the G7 countries.

Exhibit 11: The Urban Agglomeration Index

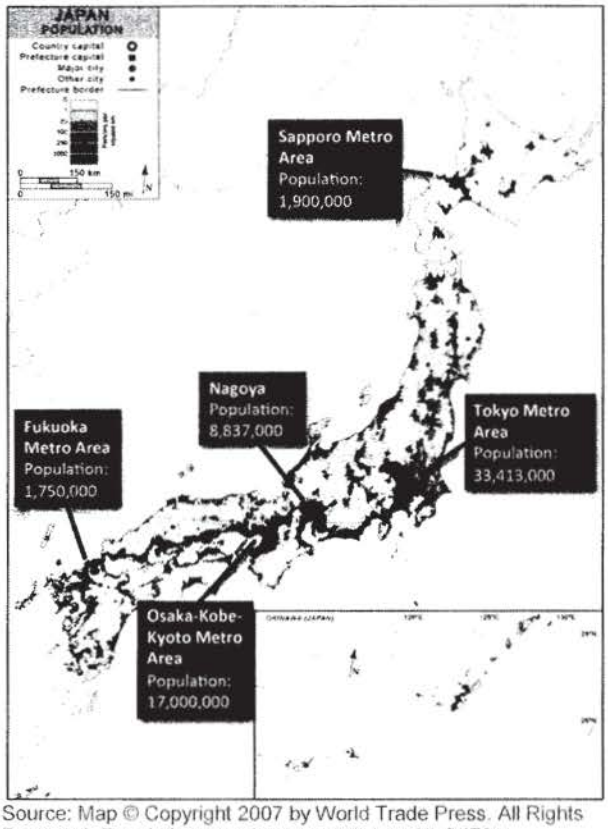


Source: Recon Analytics research, 2014

Japan and the US

Let's look at the numbers up close. In Japan, 91.3% of the population lives in urban areas and 32.2% of the urban population lives in Tokyo—the largest metropolitan agglomeration. This results in an UAI of 86.4.

Exhibit 12: Urban Agglomeration in Japan



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://bit.ly/1oSdZ8w

When we compare this with the US, differences appear. Fewer Americans than Japanese live in urban centers; only 82.4% of the US population lives in urban areas. But in stark contrast, only 7.9% of the country lives in New York—the largest metropolitan agglomeration in the US. That's because the country has a large number of major urban areas, such as Los Angeles, Chicago, Dallas, Miami, and Washington, DC. This results in an UAI for the United States of only 4.2. In contrast, Japan has an Urban Agglomeration Index that is more than 20 times that of the US.

If a carrier can cover Tokyo, it has made a huge dent in the Japanese market. And if that carrier adds the two other nearby cities along a roughly 300-mile corridor that runs from Tokyo to Nagoya and Osaka, they've basically won the battle. Just looking at the map, in Exhibit 12, shows the picture very clearly. In that corridor, there are urban agglomerations amounting to close to 60 million people—almost half of the entire population of the country.

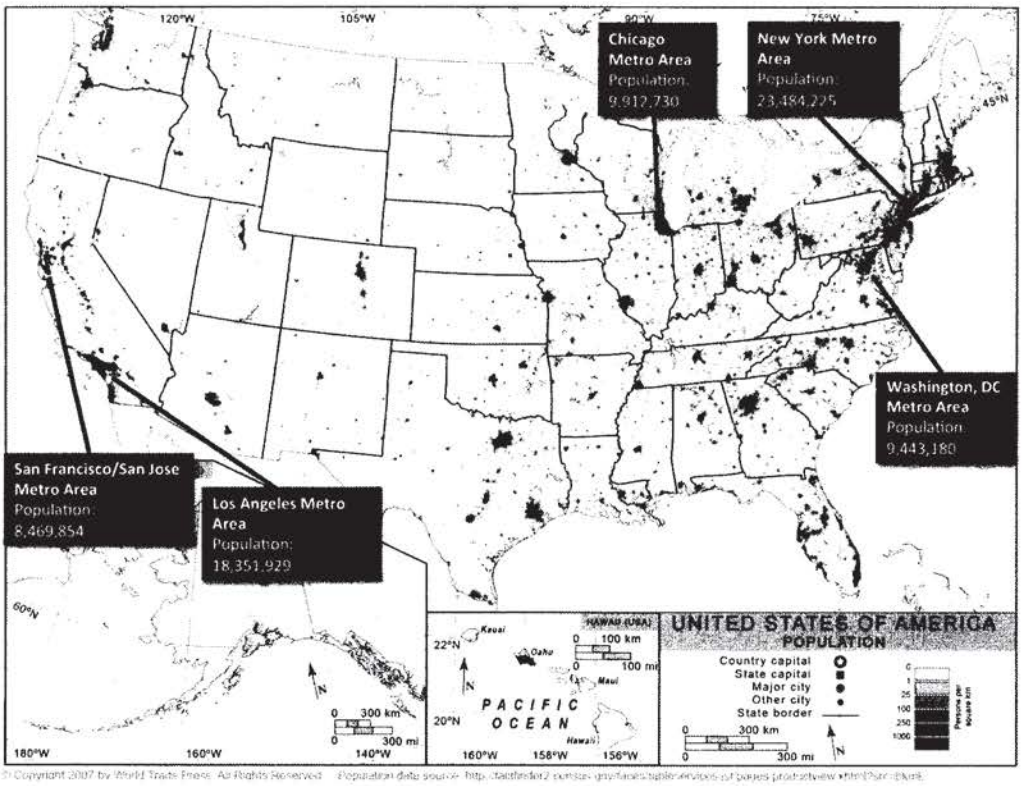
The top five metro areas in the US are New York, Los Angeles, Chicago, Washington, DC, and San Francisco/San Jose, adding up to more that 69 million people out of a total of 314 million. There are certainly a lot of people living in New York and Washington, DC, (which are the number one and number four most populated metro areas, respectively) but all told, the people there add up to only a little over 10% of the US population (see Exhibit 13).

In contrast, the population is considerably more concentrated in Japan, where the top five metro areas add up to nearly half of the Japanese population. Underscoring the difference, the top five US metro areas come to only about a fifth of the total US population. This makes the US the least concentrated G7 country and Japan the most concentrated.

In addition to the lower Urban Agglomeration Index, the metro areas in the US are far more geographically dispersed than other G7 members. San Francisco and Los Angeles are about 380 miles apart, while New York and Washington, DC, are 226 miles apart. In Europe, those kinds of distances span several countries and are thereby covered by a different set of carriers. Chicago is in the center of the country (700 miles from DC, 790 miles from NYC, 2,000 miles from Los Angeles, and 2,130 miles from San Francisco). In Europe, such distances span much of the continent.

Then there's the distance between the coasts in the US. New York is 2,900 miles from San Francisco and 2,800 miles from Los Angeles, which is almost the same distance as New York is from London. Imagine the logistics and expense for a carrier to build and maintain infrastructure that far apart. Traveling a similar distance in Continental Europe would take you from Lisbon to Moscow (albeit, not really in Europe) crossing approximately seven national borders in the process.

Exhibit 13: Urban Agglomeration in the US



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://1.usa.gov/1bkh0D4

So, because of the sheer size of the US, it's clear that the logistical complexities involved in covering the top five metro areas are considerable. Perhaps more importantly, though, as we noted, a carrier that covered each one of those metro areas would still leave 79% of the population without coverage. In fact, to the contrary, the US wireless industry now covers 97% of the US population with 4G LTE, although not with the same degree of spectrum depth devoted to LTE as many of the other G7 countries.

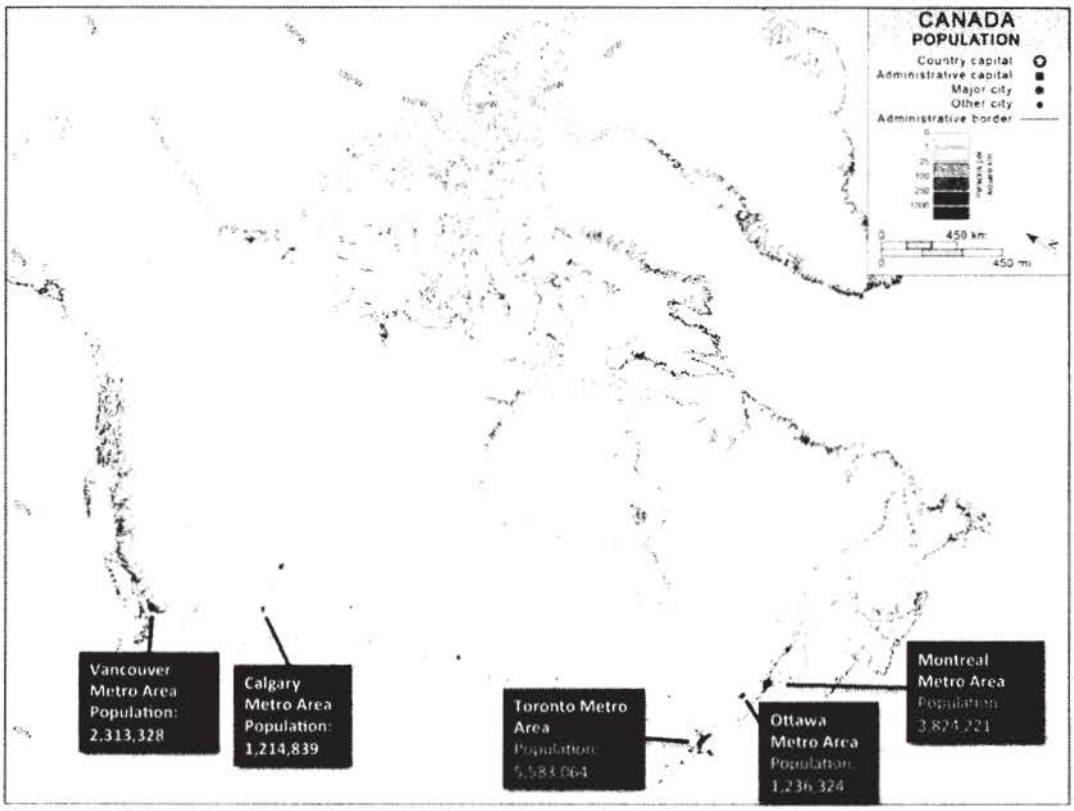
Canada

Canada, the northern neighbor of the US, is both similar and strikingly different at the same time. Roughly the same proportion of people in both countries lives in urban areas: 80.7% in Canada versus 82.4% in the United States. But Canada's population is a lot more concentrated: 75% of the Canadian population lives within 100 miles of the US border. Furthermore, 20.1% of the country lives in Toronto—the country's largest urban agglomeration, with more than 5.5 million people (see Exhibit 14). This results in an Urban Agglomeration Index of 26.31—more than six times that of the US. The second-largest urban agglomeration in Canada is Montreal, just over 300 miles away from Toronto. A mere 100 miles to the west of Montreal is Ottawa, the fourth largest urban agglomeration in Canada. Together, these three cities account for more than 30% of Canada's population.

In the west of Canada, Vancouver and Calgary (the country's third and fifth-largest urban agglomerations), account for 10% of the country's population. Vancouver lies about 420 miles to the west of Calgary.

So, it's clear that covering two fairly compact corridors in Canada, would make it easier and more cost efficient to provide top notch coverage to 40% of the country's population.

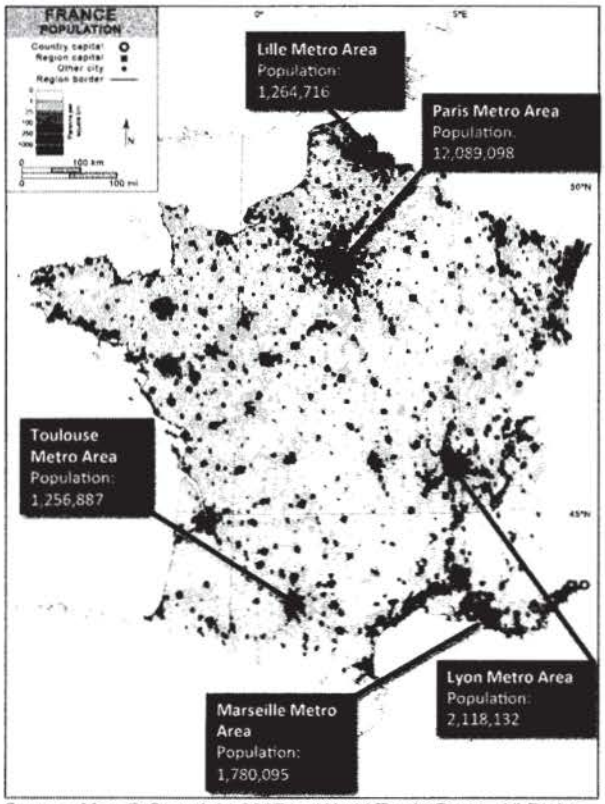
Exhibit 14: Urban Agglomeration in Canada



Source: Map © Copyright 2007 by World Trade Press. All Rights Reserved. Population data source: http://bit.ly/UE7REV

France

Exhibit 15: Urban Agglomeration in France



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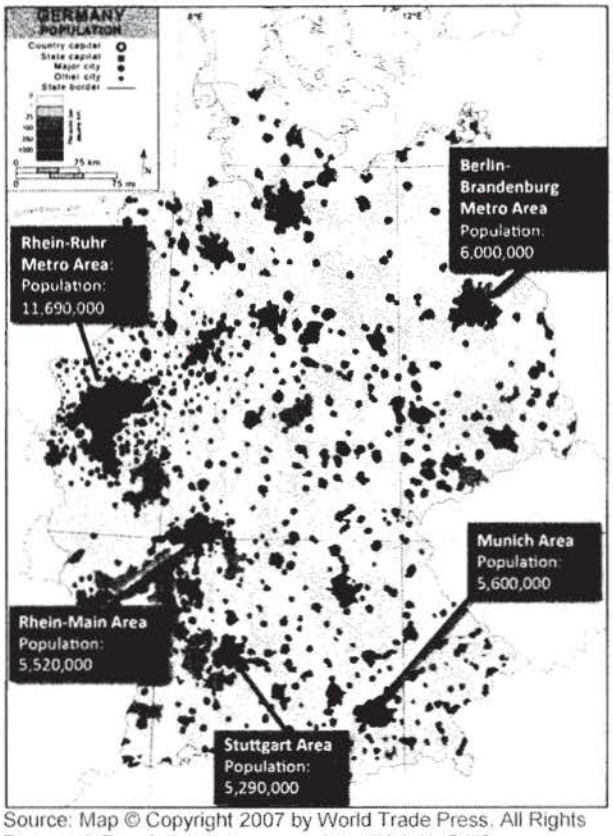
In France, 85.8% of the population lives in urban areas and 19.6% of the country lives in Paris—the country's largest urban agglomeration, with more than 12 million people (see Exhibit 15).

This results in an Urban Agglomeration Index of 28.28—the second most concentrated country among the G7 and almost seven times as concentrated than the US. The second-largest urban agglomeration in France is Lyon, just over 240 miles away from Paris. Two hundred miles to the south of Lyon is Marseilles, the third largest urban agglomeration in France.

Together, these three cities account for more than 24% of population in France. Add in Lille, the fourth largest urban agglomeration in France (just 127 miles north of Paris) and Toulouse, the fourth largest urban agglomeration (250 miles to the west of Marseilles), and a carrier could cover 25% of the population.

Germany

Exhibit 16: Urban Agglomeration in Germany



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In Germany, 73.9% of the population lives in urban areas and 14.3% of the country lives in the Rhein-Ruhr metro area—the country's largest urban agglomeration, with almost 11.7 million people (see Exhibit 16). This results in an Urban Agglomeration Index of 11.1—almost three times that of the US, but only the fifth most concentrated country among the G7.

The second-largest urban agglomeration in Germany is Berlin, just under 300 miles away from Dusseldorf, which sits at the center of the Rhein-Ruhr area. One hundred miles to the south of the Rhein-Ruhr metro area is the Rhein-Main metro area (the fourth-largest urban agglomeration in Germany), with Frankfurt at its core. Just to the south of the Rhein-Main metro area is Stuttgart, less than 100 miles away. 120 miles to the southeast of Stuttgart lay Munich (the third-largest urban agglomeration in Germany).

In the corridor between the Rhein-Ruhr urban agglomeration to 300 miles south in Munich, there are urban agglomerations accounting for more than 34% of the German population. Add in Berlin, to the northeast, and a carrier could cover almost 42% of the population, simply by operating in five markets.